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Specification and Drawing, as originally filed, with Application for Patent Serial No: **2,351,903**, on June 26, 2001, by **HER MAJESTY THE QUEEN IN RIGHT OF CANADA AS REPRESENTED BY THE MINISTER OF THE DEPARTMENT OF FISHERIES AND OCEANS,** assignee of Dave Higgs, Bob Cairns and Ian Shand, for "Process for Preparing Nutritionally Upgraded Oilseed Products". The said invention was made while Dave Higgs was employed as a public servant, as defined in the Public Servants Inventions Act in the Department of Fisheries and Oceans, pursuant to Section 5 of that Act, the said invention has been determined to be vested in **Her Majesty The Queen In Right Of Canada As Represented By The Minister Of Fisheries and Oceans**.

Agent certificateur/Certifying Officer

May 25, 2005

Date

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ABSTRACT

A process for preparation of nutritionally upgraded oilseed meal and high value oilseed oil from oilseed for use in fish or other non-human animal diets or in human foods involving the steps of subjecting the oilseed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed, dehulling the heat-treated seed to produce a meat fraction and a hull fraction, and cold pressing the meat fraction to yield an oil suitable for use in the organic human food market and a moisture containing protein and lipid-rich meal having a reduced fibre content.

PROCESS FOR PREPARING NUTRITIONALLY UPGRADED OILSEED PRODUCTS

FIELD OF THE INVENTION

The present invention relates to animal feeds, including fish feed. More specifically, it relates according to one embodiment to a process for producing nutritionally upgraded oilseed protein products for use in fish or other animal diets; other embodiments of the present invention relate to novel oilseed protein concentrates and novel protein and lipid-rich oilseed meals, as well as novel oilseed oils produced using the process of the present invention.

BACKGROUND OF THE INVENTION

Feed accounts for about 35-60% of the operating costs of salmon farms and represents the largest cost in the culture of other carnivorous aquatic species. Moreover, the protein and lipid sources presently account for the majority of the feed cost. Accordingly, salmon farming is marginal in many regions. Hence, there is a need to reduce production costs and improve the market value of the farmed product.

The use of less expensive alternative protein and lipid sources has been considered to reduce the cost of the protein and lipid sources in salmon feeds. One approach is to use protein and lipid sources that are based on processed-oilseeds rather than fish meal and oil. The plant oils need to be highly digestible with appropriate fatty acid compositions and the plant protein products need to be in the form of nutritionally upgraded meal, protein concentrates, or possibly isolates. To date, most research on oilseeds has focussed on the use of products derived from processing soybeans, rapeseed/canola, sunflower seed or cottonseed. Comparatively few of these studies, however, have been directed to assessing the feasibility of using canola, flax seed, mustard seed, hemp and the like. Indeed, in the case of canola for example, although proteins contained therein are rich in

lysine and methionine, both of which are limiting amino acids in most cereal and oilseed proteins, its use as a protein source in food products has been severely limited, due to the fact that the proteinaceous material which is left over after oil is extracted by known processes contains antinutritional constituents. The latter include insoluble and soluble fibres, glucosinolates (antithyroid compounds), phenolic compounds and phytic acid.

In cases where the above mentioned unwanted constituents are present, it has been shown that the concentrations of the above mentioned unwanted constituents should be minimized in order to allow full expression of the high quality of oilseed protein and to improve the overall digestibility, palatability, as well as bioavailability of minerals in the oilseed protein product. This is highly desirable when feeding either terrestrial species or aquatic species.

U.S. Patents No. 4,233,210 to Koch and No. 4,889,921 to Diosady et al. disclose preparations of protein concentrates for use in animal or human nourishment, from oilseeds including rapeseed (canola). The various processes of these inventions generally comprise heating, drying and distillation steps, as well as treatments with alkaline solutions and extractions with organic solvents.

The protein extract claimed by Cameron et al. in U.S. Patents Nos. 4,418,013 and 4,366,097; and by Murray et al. in U.S. Patents Nos. 5,844,086 and 6,005,076 is said to be "protein isolate", which is regarded as being different from a protein concentrate. Indeed, it is established that a protein extract is an isolate when the protein content exceeds 90% and the protein is undenatured. Accordingly, the process of the preparation of an isolate does not allow for a heating step at elevated temperature.

Lawhon et al. in U.S. Patent No. 5,086,168 disclose a process allowing for the simultaneous preparation of protein as precipitate or curd, and oil for use as food products or food ingredients, from numerous oilseeds including soybeans,

glandless, cottonseeds, sunflower seeds, peanuts and sesame seeds. At an early step of the process, a heating treatment (at about 60°C to 90°C) of the material in water is performed, in order to inactivate enzymes inherent in the seed.

A process for the preparation of rapeseed and canola protein concentrates known as the "FRI-71 process" has been described by Jones (J. Amer. Oil Chem. Soc. 56, 1979, 716-721). This process allows for the production of highly digestible protein concentrates with reduced levels of antinutritional factors (except for phytic acid) that can be used to entirely replace the fish meal portion of diets for trout. However, subsequent work conducted in collaboration with the POS Pilot Plant Corporation in Saskatoon revealed that the FRI-71 process was not cost effective, due to low yields of the concentrates, and insufficient numbers of other value-added products apart from canola oil stemming from the process. Also, the process as described could not easily be applied in the private sector using existing oilseed and fish meal processing technology.

In the present invention, a modified FRI-71 process is described that results, besides the high value canola protein concentrate and animal feed grade canola oil, in other value-added products such as canola oil suitable for the organic food market, nutritionally upgraded canola meal, and products suitable as components in organic or predominately organic fertilizers. The process of the invention is simple and economical. Moreover, the process is readily integrated into existing oilseed crushing plants or fish meal production plants.

The process described in the present invention is further extended to various oilseeds including rapeseed, sunflower seed, flax seed, mustard seed, hemp and soybeans. Moreover, mixtures of different oilseeds are also used in the process.

An object of the invention for certain embodiments is to provide an improved process for extracting protein and oil (human and animal feed grade) from oilseed. A further object of other embodiments is to provide protein products that are

particularly well suited for use in high energy (lipid) diets for fish farming and in some animal feeds.

SUMMARY OF THE INVENTION

Several aspects of the embodiments of the process according to the present invention are provided. Several novel product compositions resulting from the different process aspects are also provided.

In accordance with a first embodiment, there is provided a process for preparation of nutritionally upgraded oilseed meal and high value oilseed oil from oilseed for use in fish or other non-human animal diets or in human foods. According to a first aspect of this embodiment, the process comprises the steps of:

- subjecting said oilseed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed;
- dehulling said heat-treated seed to produce a meat fraction and a hull fraction; and
- cold pressing said meat fraction to yield an oil suitable for use in the organic human food market and a moisture containing protein and lipid-rich meal having a reduced fibre content.

In accordance with a second aspect of this embodiment, the process may comprise the further step of subjecting the protein and lipid-rich meal to enzymatic pH adjusted water treatment under conditions selected to substantially decrease the phytic acid concentration normally present in oilseed to thereby produce a protein and lipid-rich meal having reduced phytic acid and fibre contents.

In accordance with a second embodiment of the invention, there is provided a process for preparation of oilseed protein concentrates from oilseed for use in fish or other non-human animal diets comprising according to a first aspect, the steps

of:

- subjecting said oilseed seed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed;
- dehulling said heat-treated seed to produce a meat fraction and a hull fraction;
- cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a reduced fibre content;
- blending said protein and lipid-rich meal with water and an antioxidant to produce a blended mixture;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
- separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

According to a second aspect, the process of this second embodiment may comprise the steps of:

- drying the oilseed to produce dried seed;
- dehulling said dried seed to produce a meat fraction and a hull fraction;
- cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a reduced fibre content;
- blending said protein and lipid-rich meal with water and an antioxidant to produce a blended mixture;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
- separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

According to a third aspect, specifically when it is desired to produce a protein concentrate having a reduced content of phytic acid, the process may comprise the further step of subjecting the protein and lipid-rich meal to enzymatic pH adjusted water treatment under conditions selected to substantially decrease the phytic acid concentration normally present in oilseed to produce a protein and lipid-rich meal having reduced phytic acid and fibre contents.

In the first embodiment, as well as in the second embodiment of the invention, the process may start with the initial step of subjecting the oilseed to a sterilization step. This step is performed using infrared energy or other suitable techniques. The sterilization prevents the seed from germination and is systematically carried out when hemp is used in the process. The oilseed involved in the process of the invention can be selected from the group consisting of canola, rape seed, soybeans, sunflower seed, flax seed, mustard seed, cotton seed, hemp and mixtures thereof. When sunflower, canola or hemp is used in the process, the enzymatic pH adjusted water treatment step is systematically performed. Indeed canola, sunflower and hemp seeds have a high content of phytic acid.

In accordance with another aspect common to the first and second embodiments of the invention, the protein and lipid-rich meal having a reduced fibre contents and the protein and lipid-rich meal having reduced phytic acid and fibre contents, produced according to the first embodiment; as well as the protein-rich fraction produced according to the second embodiment can be subjected to a further drying step to reduce their moisture content to about 6% to 9%.

Another aspect common to the first and second embodiments deals with subjecting the protein and lipid-rich meal having a reduced fibre contents, the protein and lipid-rich meal having reduced phytic acid and fibre contents and the protein-rich fraction to the further step of solvent extraction, including the subsequent steps of solvent and meal or protein fraction recovery. In accordance with this aspect, the solvent used comprises hexane and the extraction is carried out at least twice.

In aspects of the first and second embodiments involving the heat treatment, this step can be performed at a temperature of about 100°C to about 115°C. The heat treatment can also be performed at a temperature lower than 100°C in the presence of a vacuum.

In accordance with yet another common aspect of the first and second embodiments, the dehulling step may be partial. This step can be carried out by a mechanical treatment with a gravity screening or can include an air-classification step. Other techniques including sonic techniques may also be used in the dehulling step.

In accordance with another aspect of the first and second embodiments of the invention, the cold pressing step can be performed at a temperature not exceeding 85°C and the blending step can be performed in a horizontal mixer. With respect to the cooking step, it can be desirable to effect a delay prior to subjecting the blended mixture to said cooking step.

A further common aspect to the first and second embodiments involves the used of an antioxidant, which can be selected from the group consisting of ethoxyquin (santoquin), butylated hydroxyanisole, butylated hydroxytoluene, tertiary butyl hydroquinone, natural antioxidants. Mixture of the above may also be used.

In accordance with a further aspect of the second embodiment of the invention, the drying step can be performed using a low temperature process, temperatures of about 60°C to about 83°C may be used. The stick water fraction produced in the second embodiment may further be condensed to yield condensed solubles. These may further be stabilized with an inorganic acid.

The enzymatic pH adjusted water treatment involved in some aspects of the first and second embodiments may be performed at a pH of about 5.0 to about 5.5, in the presence of enzyme phytase.

In accordance with another aspect of the second embodiment, the separation of the cooked mixture can be carried out in a screw press, expeller press or decanter centrifuge, or a combination thereof. The cooking step can be carried out using a heat exchanger or through direct steam injection coupled with a batch processor, at a temperature of about 90°C to about 93°C.

According to yet another aspect of the second embodiment, the process can involved the further step of using the condensed solubles together with hulls as components in organic fertilizers.

Dealing now with the product compositions resulting from the different process aspects of the invention, there is provided an oilseed protein concentrate for use in fish or other animal diets, containing from about 50% to about 78% protein and from about 7% to about 12% lipid. There is also provided a protein and lipid-rich oilseed meal for use in fish or other non-human animal diets, containing from about 30% to about 33% protein and about 30% to about 38% lipid. According to one aspect of the product compositions of the invention, the oilseed oil produced may be suitable for human or animal consumption.

BRIEF DESCRIPTION OF THE DRAWING

Having generally described the invention, reference will be made to the following drawing illustrating preferred embodiments only. In the drawing:

Figure 1 is a schematic diagram of the process according to one embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The steps involved in the process of the invention are illustrated in Figure 1. In this Figure, there is shown a schematic representation of the processing of oilseed to yield cold-pressed oil indicated as product 1; hulls from dehulled meats indicated

as product 2; nutritionally upgraded oilseed meal produced from heated, dehulled and cold pressed oilseed indicated as product 3; animal feed-grade oil indicated as product 4; condensed solubles indicated as product 5; and high nutritive value concentrated protein indicated as product 6. Undehulled oilseed (A) or dehulled oilseed (B) for monogastric diets may be used. An optional lipid extraction and solvent recovery step can be inserted to reduce the lipid content of the oilseed meal and just before or after press cake drying to reduce the lipid content of the protein concentrate.

The initial step involves cold pressing (temperatures <85°C using a suitable cold press) the raw whole oilseed or alternatively subjecting the raw seed to rapid heat treatment and then dehulling and cold pressing the heat-treated seed. If the latter option is selected, one procedure involves heating the seed at 110-115°C for 90 seconds followed by an additional heating at 100-110°C for 30 min. Other options require less heat depending upon the form of heat and whether or not a vacuum is applied during the heat process. The temperature and length of the treatment is selected to substantially: (i) deactivate or destroy the activity of enzymes such as myrosinase, which is the enzyme responsible for glucosinolate hydrolysis in canola; (ii) improve the digestibility or bioavailability of the carbohydrates present in canola and other oilseeds; and (iii) reduce the moisture content in the seed, which results in a partial separation of the meat from the fibrous indigestible hull. The dehulling process is further completed by subjecting the heat-treated seed through an impact, a disc, or other mechanical process coupled with a gravity screening or air-classification process. Other techniques may also be used in the dehulling process, and some of these may include sonic techniques.

The oilseed meats resulting from the cold pressing of the raw, unheated seed are not marketed directly for use in high energy animal feeds, unlike those originating from the cold pressing of heated, dehulled seed. Indeed, the latter have been nutritionally upgraded due to their reduced content of fibre and one or more heat-labile antinutritional factors. This meal contains about 30-33% protein and 30-38%

lipid. It may be used as is or it may be further subjected to solvent extraction involving hexane, with subsequent recovery of the solvent and the meal to reduce its lipid content, thus elevating its protein concentration. The meal may be directly channelled into diets of aquatic and terrestrial species, or similar to the meal from the unheated, pressed seed, submitted without lipid extraction to the next step of the process. The cold pressed oils from both sources, however, are channelled into the organic human food market.

The meals from undehulled or dehulled oilseed are blended with a suitable amount of water (about 4-8:1 w/w water to oil-free dry matter of meal) and an antioxidant (e.g. 100 mg of santoquin/kg of meal). The added water serves to wash the oilseed meal as the blend moves through the cooker to either a continuous screw press that is surrounded with perforated screens or an expeller press. As the presscake moves through this stage of the apparatus, fluids are drained off that include water that contains soluble protein, some of the remaining water soluble antinutritional components such as glucosinolates (when canola is used), phenolic compounds and unwanted sugars like raffinose and stachyose; as well as a large portion of the lipid fraction. The mechanical separation of the aforementioned solids and liquid fractions may also involve the use of a decanter centrifuge depending upon the efficiency of liquid/solid separation after the presscake has passed through the screw press or expeller.

Thereafter, the fluid mixture is separated by continuous centrifuge into stick water and animal feed grade oil fractions (the latter may be subjected to additional processing steps as referred to previously to create a human grade oil). The press-cake meal is dried using a low temperature process (temperature of about 60°C to about 83°C) to yield a dried protein-rich fraction (concentrate).

In cases where the lipid content of the dried protein fraction is too high for the desired animal feed use, a solvent extraction step involving hexane is performed, with subsequent recovery of the solvent and the animal feed grade oil. In another

embodiment of the invention, the solvent extraction step is performed prior to the low temperature drying step.

The stick water fraction mentioned above is condensed to about a third of its original volume and following acid stabilization, is then used together with the hulls as components in organic fertilizers for agriculture.

The oilseed in accordance with the present invention is selected from: canola, rape seed, soybeans, sunflower seed, flax seed, mustard seed, cotton seed and hemp or mixtures of these oilseeds. The oilseed used in the process of the invention can also consist of a mixture of two or more different oilseeds selected from the above-mentioned oilseeds. A suitable selection of oilseeds to be mixed together in the process will provide for products with enhanced nutritional values. With respect to the protein product, the amino acid profile can be obtained through amino acid complementation. Further, oil could be upgraded through, for example using a mixture of oleic acid, sunflower or yellow mustard with flax seed and/or canola. Such oil would have high oleic acid content and low or intermediate concentrations of linolenic acid. Also, these oils will have reduced concentrations of linoleic acid.

In accordance with the invention, oilseeds having a high content of phytic acid, such as canola, sunflower and hemp can be subjected to enzymatic pH adjusted water treatment prior to being used in the process. This pretreatment involves adjustment of pH to about 5.0 to about 5.5 and addition of enzyme phytase. The oilseeds in particulate form are incubated with phytase for about 4 hours or more, at a temperature of about 50°C to about 55°C. In the case of hemp, the seeds have to undergo a sterilization step, to prevent germination and this may be accomplished by using infrared energy or other suitable techniques. The dehulling step is imperative in the case of flax seed. Alternatively, removal of at least the mucilage layer in the outer seed coat should be carried out.

When sunflower or canola is used in the process of the invention in the production

of protein concentrates, the heat treatment step may be avoided, however, in order to facilitate dehulling (specifically if mechanical dehulling is being performed), the seeds are subjected to a drying step, to reduce their moisture content to about 5%.

Given the above teachings, it will be seen that the invention also provides protein concentrates produced by the above process, containing from about 50% to about 78% protein, that are highly digestible and significantly depleted in antinutritional constituents (except for phytic acid in some cases if the seeds are not pretreated with phytase) that were present in the original oilseed. The oilseed protein concentrates of the present invention have moderate contents of lipids (from about 5% to about 12%) that include highly digestible monounsaturated and polyunsaturated fatty acids

WE CLAIM:

1. A process for preparation of nutritionally upgraded oilseed meal and high value oilseed oil from oilseed for use in fish or other non-human animal diets or in human foods comprising the steps of:

   - subjecting said oilseed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed;
   - dehulling said heat-treated seed to produce a meat fraction and a hull fraction; and
   - cold pressing said meat fraction to yield an oil suitable for use in the organic human food market and a moisture containing protein and lipid-rich meal having a reduced fibre content.

2. The process according to claim 1, further comprising the steps of subjecting said protein and lipid-rich meal to enzymatic pH adjusted water treatment under conditions selected to substantially decrease the phytic acid concentration normally present in oilseed to thereby produce a protein and lipid-rich meal having reduced phytic acid and fibre contents.

3. A process for preparation of oilseed protein concentrates from oilseed for use in fish or other non-human animal diets comprising the steps of:

   - subjecting said oilseed seed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed;
   - dehulling said heat-treated seed to produce a meat fraction and a hull fraction;
   - cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a

reduced fibre content;

- blending said protein and lipid-rich meal with water and an antioxidant to produce a blended mixture;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
- separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

4. A process for preparation of oilseed protein concentrates from oilseed for use in fish or other non-human animal diets comprising the steps of:
   - drying said oilseed to produce dried seed;
   - dehulling said dried seed to produce a meat fraction and a hull fraction;
   - cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a reduced fibre content;
   - blending said protein and lipid-rich meal with water and an antioxidant to produce a blended mixture;
   - cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
   - separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

5. The process according to claim 3 or 4, further comprising the steps of subjecting said protein and lipid-rich meal to enzymatic pH adjusted water treatment under conditions selected to substantially decrease the phytic acid concentration normally present in oilseed to produce a protein and lipid-rich meal having reduced phytic acid and fibre contents.

6. The process according to any one of claims 1 to 5, further comprising an initial step of sterilizing said oilseed.

7. The process according to claim 6, wherein said sterilization step is performed using infrared energy.

8. The process according to claim 1, further comprising the step of drying said protein and lipid-rich meal having a reduced fibre contents to thereby reduce its moisture content to about 6% to 9%.

9. The process according to claim 2, further comprising the step of drying said protein and lipid-rich meal having reduced phytic acid and fibre contents to thereby reduce its moisture content to about 6% to 9%.

10. The process according to any one of claims 3 to 6, further comprising the step of drying said protein-rich fraction to reduce its moisture content to about 6% to 9% to yield a high value oilseed protein concentrate.

11. The process according to any one of claims 1 to 6, wherein said oilseed is selected from the group consisting of canola, rape seed, soybeans, sunflower seed, flax seed, mustard seed, cotton seed, hemp and mixtures thereof.

12. The process according to claim 4, wherein said oilseed is sunflower canola or hemp.

13. The process according to claim 6 or 7, wherein said oilseed is hemp.

14. The process according to claim 1, wherein said protein and lipid-rich meal having a reduced fibre content is further subjected to a solvent extraction step, and further includes the subsequent steps of solvent and meal

recovery.

15. The process according to claim 2, wherein said protein and lipid-rich meal having reduced phytic acid and fibre contents is further subjected to a solvent extraction step, and further includes the subsequent steps of solvent and meal recovery.

16. The process according to any one of claims 3 to 5, wherein said protein-rich fraction is further subjected to a solvent extraction step, and further includes the subsequent steps of solvent and meal recovery.

17. The process according to any one of claims 14 to 16, wherein said solvent comprises hexane.

18. The process according to any one of claims 14 to 16, wherein said solvent extraction step is carried out at least twice.

19. The process according to any one of claims 1 to 3, wherein said heat treatment is performed at a temperature of about 100°C to about 115°C.

20. The process according to any one of claims 1 to 3, wherein said heat treatment is performed at a temperature lower than 100°C in the presence of a vacuum.

21. The process according to any one of claims 1 to 6, wherein said dehulling is a partial dehulling step.

22. The process according to any one of claims 1 to 6, wherein said dehulling is carried out by a mechanical treatment with a gravity screening or air-classification step.

23. The process according to any one of claims 1 to 6, wherein said dehulling is carried out using sonic techniques.

24. The process according to any one of claims 1 to 6, wherein said cold pressing is performed at a temperature not exceeding 85°C.

25. The process according to any one of claims 3 to 5, wherein said blending is performed in a horizontal mixer.

26. The process according to any one of claims 3 to 5, further comprising the step of effecting a delay prior to subjecting said blended mixture to said cooking step.

27. The process according to any one of claims 3 to 5, wherein said antioxidant is selected from the group consisting of ethoxyquin (santoquin), butylated hydroxyanisole, butylated hydroxytoluene, tertiary butyl hydroquinone, natural antioxidants and mixtures thereof.

28. The process according to claim 4, wherein said drying is performed using a low temperature process, at a temperature of about 60°C to about 83°C.

29. The process according to any one of claims 3 to 5, further comprising the step of condensing said stick water fraction to yield condensed solubles.

30. The process according to claim 29, further comprising the step of stabilizing said condensed solubles with an inorganic acid.

31. The process according to claim 2 or 5, wherein said enzymatic pH adjusted water treatment is performed at a pH of about 5.0 to about 5.5, in the presence of enzyme phytase.

32. The process according to any one of claims 3 to 5, wherein said separation of said cooked mixture is carried out in a screw press, expeller press or decanter centrifuge, or a combination thereof.

33. The process according to any one of claims 3 to 5, wherein said cooking step is carried out using a heat exchanger or through direct steam injection coupled with a batch processor.

34. The process according to any one of claims 3 to 5, wherein said cooking step is carried out at a temperature of about 90°C to about 93°C.

35. An oilseed protein concentrate for use in fish or other animal diets, produced in accordance with any one of claims 3 to 5 or any of their dependant claims, containing from about 50% to about 78% protein and from about 7% to about 12% lipid.

36. A protein and lipid-rich oilseed meal for use in fish or other non-human animal diets, produced in accordance with claim 1 or 2 or any of their dependant claims, containing from about 30% to about 33% protein and about 30% to about 38% lipid.

37. An oilseed oil produced in accordance with any one of claims 1 to 6 or any of their dependant claims, suitable for human or animal consumption.

38. The process according to any one of claims 3 to 5, further comprising the step of using said condensed solubles together with hulls as components in organic fertilizers.

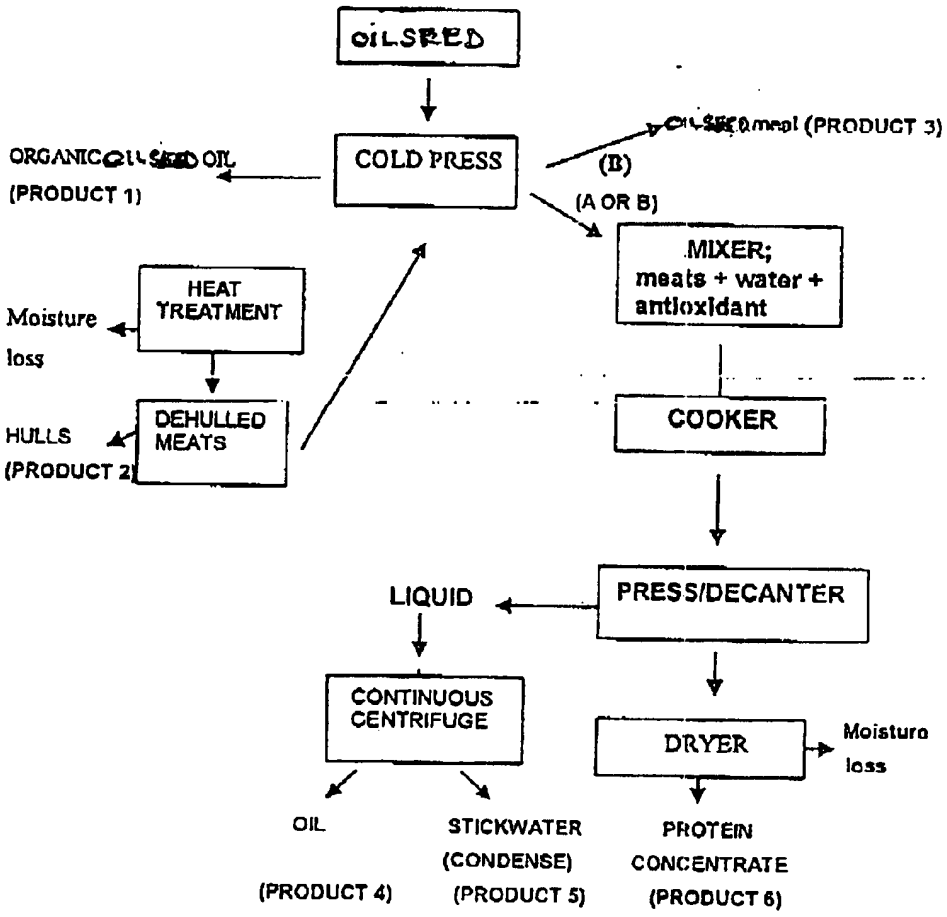
OILSEED
COLD PRESS
ORGANIC OIL
(PRODUCT 1)
(B)
(A OR B)
MIXER;
meats + water +
antioxidant
HEAT
TREATMENT
Moisture
loss
DEHULLED
MEATS
HULLS
(PRODUCT 2)
COOKER
PRESS/DECANTER
LIQUID
CONTINUOUS
CENTRIFUGE
DRYER
Moisture
loss
OIL
(PRODUCT 4)
STICKWATER
(CONDENSE)
(PRODUCT 5)
PROTEIN
CONCENTRATE
(PRODUCT 6)

Figure 1